

CLAIMS

What is claimed is:

- 1 1. A method of determining a parameter of interest of an earth formation using a tool
2 conveyed in a borehole in the earth formation, the method comprising:
 - 3 (a) obtaining measurements indicative of said parameter of interest with a first
4 resistivity measuring instrument responsive to a property of the earth
5 formation proximate to the borehole (near zone);
 - 6 (b) determining from said measurements a first model comprising a property
7 of said near zone,
 - 8 (c) obtaining multicomponent measurements indicative of a vertical resistivity
9 of said earth formation; and
 - 10 (d) determining from said first model and said multicomponent measurements
11 said parameter of interest.
12
- 1 2. The method of claim 1 wherein said property of said first model comprises at least
2 one of (i) a thicknesses of a plurality of layers, (ii) a length and resistivity of an
3 invaded zone corresponding to said plurality of layers, and, (iii) horizontal
4 resistivities of said earth formation outside said invaded zone.
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- 1 3. The method of claim 1 wherein said parameter of interest comprises at least one
2 of (i) a vertical resistivity of said earth formation, and, (ii) an anisotropy factor for
3 said earth formation.

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1 4. The method of claim 1 wherein said first resistivity measuring instrument
2 comprises a galvanic instrument.

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1 5. The method of claim 4 wherein said galvanic instrument comprises at least one of
2 (i) a Dual Laterolog/Microlaterolog (DLL/MLL), and, (ii) a High-Definition
3 Lateral Log/Microlaterolog (HDLL/MLL).

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1 6. The method of claim 1 wherein determining said first model comprises
2 performing an inversion of measurements made by said first instrument.

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1 7. The method of claim 1 wherein determining said parameter of interest further
2 comprises performing an inversion of said multicomponent measurements
3 wherein said thicknesses of said layers, and said length and resistivity
4 corresponding to each of said plurality of layers are fixed in said inversion.

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1 8. The method of claim 7 wherein performing said inversion further comprises
2 defining a global objective function that is the sum of a data objective function
3 and a model objective function.

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1 9. The method of claim 7 wherein performing said inversion further comprises using
2 a rapid inversion algorithm.

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1 10. The method of claim 9 wherein said rapid inversion is performed substantially at
2 the well site.

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1 11. The method of claim 1 wherein said multicomponent measurements comprise
2 measurements made at a plurality of frequencies.

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1 12. The method of claim 1 wherein said multicomponent measurements comprise
2 measurements made at two frequencies.

1 13. An apparatus for use in a borehole in an earth formation for determining a
2 parameter of interest of the earth formation, the apparatus comprising:

- 3 (a) a first resistivity measuring instrument responsive to a property of the
4 earth formation proximate to the borehole (near zone);
5 (b) a processor for determining from said measurements made by said first
6 instrument a first model comprising properties of said near zone,
7 (c) a second resistivity measuring instrument for obtaining measurements
8 indicative of a vertical resistivity of said earth formation; and
9 (d) a processor for determining said parameter of interest from said first
10 model and said measurements mad by said second instrument.

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1 14. The apparatus of claim 13 wherein said first instrument comprises a galvanic
2 instrument.

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1 15. The apparatus of claim 14 wherein said galvanic instrument comprises at least one
2 of (i) a Dual Laterolog/Microlaterolog (DLL/MLL), and, (ii) a High-Definition
3 Lateral Log/Microlaterolog (HDLL/MLL).

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1 16. The apparatus of claim 14 wherein said galvanic instrument comprises an array
2 device.

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1 17. The apparatus of claim 14 wherein said second instrument comprises an
2 induction device having a plurality of transmitter-receiver combinations,
3 wherein at least one transmitter or at least one receiver comprises an antenna
4 with an axis inclined to an axis of the second instrument.

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1 18. The apparatus of claim 14 wherein said model further comprises (i) thicknesses
2 of a plurality of layers, (ii) a length and resistivity of an invaded zone
3 corresponding to said plurality of layers, and, (iii) a horizontal resistivity of said
4 earth formation outside said invaded zone.

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1 19. The apparatus of claim 13 wherein said parameter of interest comprises at least
2 one of (i) a vertical resistivity of said earth formation, and, (ii) an anisotropy
3 factor for said earth formation.

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- 1 20. The apparatus of claim 13 wherein determining said first model comprises
2 performing an inversion of measurements made by said first instrument.
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- 1 21. The apparatus of claim 13 wherein determining said parameter of interest further
2 comprises performing an inversion of said measurements made by said second
3 instrument wherein said thicknesses of said layers, and said length and resistivity
4 corresponding to each of said plurality of layers are fixed in said inversion.
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- 1 22. The apparatus of claim 13 wherein said processor in (d) performs said inversion
2 substantially at the well site.
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- 1 23. The apparatus of claim 13 wherein at least one of said processor in (b) and said
2 processor in (d) is at a surface location.
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- 1 24. The apparatus of claim 13 wherein at least one of said processor in (b) and said
2 processor in (d) is at a downhole location.
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- 1 25. A system for estimating a parameter of interest of an earth formation penetrated
2 by a borehole, the system comprising:
3 (a) a first resistivity measuring instrument responsive to a property of the
4 earth formation proximate to the borehole (near zone);
5 (b) a processor for determining from said measurements made by said first
6 instrument a first model comprising properties of said near zone,

- 7 (c) a second resistivity measuring instrument for obtaining measurements
8 indicative of a vertical resistivity of said earth formation;
9 (d) a processor for determining said parameter of interest from said first
10 model and said measurements made by said second instrument; and
11 (e) a conveyance device for conveying said first and second instruments into
12 said borehole.

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1 26. The system of claim 25 wherein said conveyance device comprises a wireline.

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1 27. The system of claim 25 wherein said conveyance device comprises coiled tubing.

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1 28. The system of claim 25 wherein said conveyance device comprises a drilling
2 tubular.

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1 29. The system of claim 25 wherein said second instrument comprises an induction
2 device having a plurality of transmitter-receiver combinations, wherein at least one
3 transmitter or at least one receiver comprises an antenna with an axis inclined to
4 an axis of the second instrument.

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30. The system of claim 25 further comprising an additional instrument for
determining a parameter of interest of said earth formation.